Education on Reserve Practices across RTOs/ISOs

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Disclaimer

PJM has compiled this information from publicly available data and documents (i.e. business manuals, governing documents, FERC filing materials, etc.) in Q4 2023.

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Primary Reserves Procured Quantities

	Primary Reserve Requirement	Synchronous (or Spinning) Requirement
PJM	150% of the Synchronous Reserve Requirement (inclusive of the synchronous reserves)	100% of the most severe single contingency (MSSC), currently increased to 130% to account for performance.
ISO NE	100% MSSC	25-100% of the primary reserve requirement must be met by spinning depending on historic ACE recovery performance.
MISO	100% MSSC	50% of the primary reserve requirement must be met by spinning
NYISO	100% MSSC	50% of the primary reserve requirement must be met by spinning
SPP	100% MSSC * performance factor. Current performance factor is 1.3.	50% of the primary reserve requirement must be met by spinning
CAISO	At least 100% MSSC, but can be increased by load levels and online photovoltaics	Minimal spinning reserve requirements are set for each ancillary service region.

Must-Offer Requirements

PJM	All generation capacity resources must offer in their reserve capability.
ISO NE	Reserve capability on resources participating in the energy market is calculated by ISO NE and is assumed to be available for reserves.
MISO	Capacity resources not on a forced or maintenance outage must offer in their reserve capability if qualified.
NYISO	Any resource eligible to supply operating reserves and that is available to NYISO for dispatch must also make itself available to provide operating reserves.
SPP	With the exception of wind and solar, resources that are capable of providing reserves must offer into the reserve market.
CAISO	Resource adequacy resources subject to the ancillary service must offer obligation must offer into the reserve market.

Primary Reserve Performance Requirements

PJM	Primary reserve resources must be able to respond within 10 minutes and sustain a response for 30 minutes.
ISO NE	Primary reserve resources must be able to respond within 10 minutes and sustain response for 60 minutes.
MISO	Primary reserve resources must be able to respond within 10 minutes and sustain a response for 60 minutes.
NYISO	Primary reserve resources must be able to respond within 10 minutes and sustain a response for 60 minutes.
SPP	Primary reserve resources must be able to respond within 10 minutes and sustain a response for 60 minutes.
CAISO	Primary reserve resources must be able to respond within 10 minutes and sustain a response for 120 minutes.

Synchronous Reserve Capability Modeling

PJM	With the exception of resources using the energy storage resource participation model, hydro and demand response, PJM calculates resource reserve capability based on the submitted energy offer and reserve-specific parameters (e.g., spin max).
ISO NE	ISO NE calculates resource reserve capability based on the submitted energy offer.
MISO	MISO calculates resource reserve capability based on its active ramp rates and/or the clearing of other products on the resource.
NYISO	A resource's maximum operating reserve level is ten times its emergency response rate as provided by the supplier.
SPP	Resources offer in their reserve capability.
CAISO	Adequacy resources must offer in their reserve capability. If no reserve offer is provided, the resource's reserve capability is calculated by CAISO based on its energy offer.

Resource Testing

PJM	There are no resource testing requirements for reserves.
ISO NE	ISO NE tests the ability of resources to provide reserves at regular intervals, when possible in coordination with the resource's normal testing practices.
MISO	MISO does qualification testing to provide offline supplemental reserve, but not for synchronized reserves.
NYISO	All resources requesting to become reserve suppliers and all resources that must re-qualify must complete a pre-qualification performance test.
SPP	SPP does random testing, and if a resource fails a random test, they are barred from clearing until they can pass a subsequent test.
CAISO	CAISO has the ability to conduct unannounced tests to verify resources' ability to meet reserve performance requirements.

Locational Reserves

PJM	PJM has the ability to set reserve requirements based on flexible reserve sub-zones to manage system constraints. Only one sub-zone can be in effect at a time.
ISO NE	ISO NE has four reserve zones.
MISO	Studies are conducted quarterly to establish the number and composition of MISO's reserve zones.
NYISO	NYISO has four reserve zones.
SPP	SPP has five reserve zones.
CAISO	CAISO has ancillary service regions, which have separate minimum spinning reserve requirements.

Resource Offer $

PJM	Resources may offer up to the expected penalty rate for providing synchronous reserves.
ISO NE	There are no distinct resource offers for reserve products in the real-time market, and so clearing prices are purely opportunity-cost based.
MISO	Resources may submit contingency reserve offers in $/MW in the allowable range of $0 to $100 per MW. Offers default to $0 per MW if not provided.
NYISO	Resources can provide reserve capability bids in the day ahead market in $/MW. During real-time, all suppliers are automatically assigned an operating reserves availability bid of $0 per MW.
SPP	Resources may submit spinning reserve offers in the allowable range of -$100 to $100 per MW.
CAISO	Resources' ancillary services bids must include a bid price of the capacity reservation for reserves in $/MW, capped at the ancillary services bid price of $250 per MW.

Reserve Deployment

PJM	During a synchronized event, PJM deploys all synchronized reserves via an All-Call and asks them to ramp up to their maximum capability.
ISO NE	Operators run a Contingency Scheduling Pricing and Dispatch economic dispatch engine, which sends out a special emergency dispatch instruction, which resources must acknowledge within 60 seconds.
MISO	Operators deploy reserve MWs depending on the resource loss or other system conditions. Deployment is proportional across generation resources with a reserve assignment and based on merit order for demand response. MISO may switch early to a SCED solution that reflects the applicable systems conditions if available and may re-execute RTSCED if the event occurs early in the dispatch interval.
NYISO	Operators initiative a reserve pickup, and units with or without a reserve award are expected to respond with their emergency response rate as bid. Units are paid for any over-generation during the reserve pick-up and for a grace period of three intervals (15 minutes) following.
SPP	Operators decide how many MWs of reserves to deploy and enter that into a reserve deployment tool. Reserves are deployed pro rata across resources with a reserve assignment, beginning with spinning reserves. Reserve assignments are added automatically to the dispatch basepoint.
CAISO	A real-time contingency dispatch tool is activated when a SE solution is available post contingency to produce dispatch instructions for a 10 minute interval using Energy Bid prices. If 300MW or more are needed, a real-time disturbance dispatch is done that dispatches resources based on merit order without a network model, starting with resources that have a reserve assignment.

Performance Evaluation

PJM	A resource's reserve performance is measured based the difference in its output at the beginning and end of the deployment event respectively.
ISO NE	For non-spinning reserves (cleared in the Forward Reserve Market), the actual amount of energy delivered is measured at the 10 minute point following deployment. If the resource becomes unavailable within 60 minutes, its response is reduced to zero. For contingency dispatch events, resources are evaluated on whether they acknowledge the emergency dispatch notification within 60 seconds and then follow dispatch instructions.
MISO	Resources can pass the reserve performance test by meeting any of four conditions: 1) meeting or exceeding the deployment instruction, 2) meeting or exceeding its expected output based on a linear ramp, 3) exceeding the change in output in the deployment instruction, or 4) exceeding its expected change in output.
NYISO	NYISO measures actual resource output or demand reduction against its expected performance and may disqualify resources that consistently fail to perform from providing reserves in the future.
SPP	Resources can pass the reserve performance test by meeting at least 75% of its obligation as measured by any of four tests, two based on its MW output delta, and two based on its calculated ramp capability. If the resource fails, its highest performance measure is used to de-rate its assignments for the remainder of the operating day.
CAISO	Ten minutes after deployment, resources must provide at least 90% of the amount of energy requested, measured using resource telemetry.

Penalties for Non-Performance

PJM	Resource non-performance results in an obligation to repay all or a portion of the reserve credits it received.
ISO NE	Reserves with an obligation in the Forward Reserve Market (non-spinning and 30-minute reserves) that fail to perform must pay back the greater of a failure to activate rate or the real-time LMP.
MISO	Resource that do not perform when called upon must buy back their MW deficiency at the real-time LMP. Any additional cleared reserves that were not deployed do not receive reserve payment for that hour.
NYISO	Resource must buy out of its day-ahead reserve commitment at the real-time reserve market clearing price. Repeated failure may disqualify resources from providing reserves in the future.
SPP	Buy-back portion of the reserves at the real-time reserve clearing price. Resources that don't pass their performance test are de-rated based on actual performance for the remainder of the operating day.
CAISO	If a resource fails to provide reserves when called upon to do so, its reserve capacity payments are rescinded.

Modeling Transition Times for Multi-Configuration Resources

ISO NE	ISO NE does not have a model for a holding period when the market participant changes configuration, and they use the MW-dependent ramp rate model whereby resources can express these limitations by using a small ramp rate (0.1 MW/min) during these transition times.
MISO	Combined cycle plants are typically modeled as separate resources based on unit type, but resource owners can opt to model the resource as a single combined resource and represent transition times using the minimum ramp rate. During real-time, operators can then change a flag indicating that the resource is off-control during transition times so that the resource will not clear for reserves. MISO's long term plan is to implement a Multiple Configuration Resource model, but that is several years out.
NYISO	For operating reserve scheduling, the emergency response rate is used, which is a single value required to be greater than or equal to all normal response rates. NYISO is planning to undertake a process in 2024 to evaluate using multiple ramp rates for scheduling reserves and allowing limited participation for reserve products to account for plant operational limitations (project overview).
SPP	For most resources, SPP uses the ramp rate, and has a minimum ramp rate of 0.0001 MW/min. For combined cycle resources (and possibly others moving forward), SPP has a Multi-Configuration Resource model that includes transition times. If the transition times are > 30 minutes, then resources cannot clear reserves in the transition hour. For transition times < 30 minutes, they can clear for Transitional Supplemental Reserves, which is akin to offline Supplemental Reserves.
CAISO	CAISO has a Multi-Stage Generation model, which includes transition times. The optimization will therefore not clear reserves on resources during transition periods.

Modeling Transition Times for Multi-Configuration Resource (PJM)

PJM	Resource owners can elect to have combined cycle units modeled as separate resources based on unit type using PJM's pseudo modeling guidelines (pseudo modeling white paper) **or** as a single combined resource and represent transition times using the minimum ramp rate (IMM presentation on resource modeling and ramping capability calculation).

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Acronyms

Acronym	Term & Definition
LMP	**Locational Marginal Price** is defined as the marginal price for energy at the location where the energy is delivered or received. For accounting purposes, LMP is expressed in dollars per megawatt-hour ($/MWh). LMP is a pricing approach that addresses Transmission System congestion and loss costs, as well as energy costs.
MSSC	The **Most Severe Single Contingency**, as defined by the North American Electric Reliability Corporation (NERC), is the Balancing Contingency Event, due to a single contingency, that would result in the greatest loss (measured in MW) of resource output used by the Reserve Sharing Group (RSG) or a Balancing Authority that is not participating as a member of a RSG at the time of the event to meet firm system load and export obligation (excluding export obligation for which Contingency Reserve obligations are being met by the sink Balancing Authority).
ACE	**Area Control Error** is a signal generated by the PJM Control Center and sent to the plants, stations and/or PJM members scheduled to provide regulation to change generation quickly to keep PJM's area control error within allowable limits. It is used to control for small fluctuations in load.
MW	A **Megawatt** is a unit of power equaling one million watts (1 MW = 1,000,000 watts) or one thousand kilowatts (1 MW = 1,000 KW). To put it in perspective, under non-severe weather conditions, one MW could power roughly 800 to 1,000 average-sized American homes.

PJM Glossary

PROTECT THE POWER GRID

THINK BEFORE YOU CLICK!

pjm

Be alert to malicious phishing emails.

Report suspicious email activity to PJM.

(610) 666-2244 / it_ops_ctr_shift@pjm.com